170-TP-002-001

Pre-Processing of NESDIS and TOMS Ancillary Data Sets

Technical Paper

4 96

Prepared Under Contract NAS5-60000

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Abstract

This white paper discusses the background behind the need for NESDIS and TOMS ancillary data, and the requirement to pre-process the data in a form suitable for use within ECS.

Specifically, this document will discuss the issues surrounding the choice of these data sets, and present both an object model and functional model for the pre-processing of the NESDIS data set. The TOMS data set is not included since it is not anticipated that pre-processing will be necessary for reasons discussed in the text.

Keywords: NESDIS, EDR, MasterMap, TOMS, ancillary, pre-processing

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1. Introduction

1.1 Purpose

The purpose of this white paper is to present the object model and functional model for the pre-processing of NESDIS data in EDR MaterMap format. It also includes a discussion on the need for the pre-processing of NESDIS and TOMS data. This document's origin is based on discussions with Data Engineering and on the need to clarify the pre-processing requirements. Inputs are based on discussion with Data Engineering, Science Office (regarding TOMS data) and INGEST (object and functional model).

The object model will be incorporated into the Ingest Subsystem Detailed Design contained in DID-305 release (September 1996).

The actual level 3 requirements which are satisfied by this work are as follows:

- SDPS-0020

  The SDPS shall receive ... non-EOS data... and ancillary data (as listed in Appendix C) from the ADCs, EPDSs and ODCs,

- DADS0770

  The DADS shall reformat data sets in one of the approved standard formats including HDF,

- DADS0800

  Each DADS shall provide the capability to translate input data to the internal ECS-format including HDF.

These requirements are derived from Functional and Performance Requirements Specification, chapter 3 (423-41-02) . Currently, the level-4 requirements are the subject of an outstanding CCR. This work has gone ahead with the approval of senior ECS personnel, under the contract extension WBS 1.7.

During the proposal for the contract extension under which this work is performed, an extensive survey of the science community was carried out which proposed that pre-processing of common ancillary data products would be beneficial. Three common data sets were identified; NMC GRIB, NESDIS Snow/Ice products and TOMS products. The preprocessing of NMC GRIB is already dealt with and documented in the technical paper 170-TP-001-001. This document deals solely with TOMS and NESDIS Snow/Ice products.

This document will also describe the data model for the pre-processed data. Note that the data will be stored in both native and HDF-EOS format.

1.2 Organization

This paper is organized as follows:

Section 2 : Overview of Data formats for pre-processing,

Section 3 : Object and functional models for pre-processing of NESDIS Snow/Ice Data

Section 4 : Data format specification for output products.

1.3 Review and Approval

This White Paper is an informal document approved at the Office Manager level. It does not require formal Government review or approval; however, it is submitted with the intent that review and comments will be forthcoming.

The ideas expressed in this White Paper are intended to remain valid for the duration of the project and the concepts presented here are expected to migrate into the following formal CDRL deliveries:

Table 1-1. White Paper to CDRL Migration

White Paper Section	CDRL DID/Document Number
3	DID-305
4	DID-311

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1.4 Reference Documents

Functional and Performance Requirements Specification, Chapter 3; 11/94 (424-41-02)

GRIB Format Pre-Processing Design and Issues; 12/95 (240-WP-002-001)

PreProcessing of NMC GRIB Formatted Products; 3/96 (170-TP-001-001)

Mastermap Microwave Derived Products (EDR) Interface Control Document; Akunuri, R., Pritchard, J., and Dennis, L.; 12/92

Interface Control Document Between the EOSDIS Core System (ECS) and the Goddard Space Flight Center (GSFC) Distributed Active Archive Center (DAAC) for the ECS Project; 1/96 (209-CD-008-003)

Interface Control Document Between the EOSDIS Core System (ECS) and the National Oceanic and Atmospheric Administration (NOAA) Affiliated Data Center (ADC) for the ECS Project; 12/95 (209-CD-006-004)

Release A SDPS Ingest Subsystem Design Specification; 7/95 (305-CD-009-001)

2. Data Formats for Preprocessing

The need for pre-processing was identified following a review of the ancillary data sets required by the science teams which took place during the summer of 1994. This identified a number of such data sets, some of which were required by more than one science team. After discussions, it was decided that these data sets (listed in table 2.1) would be pre-processed to HDF-EOS to provide data sets which are easily used within the PGE subsystem. In this way there would be reduced duplication of effort across science teams in developing code to access data points required. Instead, standard HDF-EOS library calls could be used to extract data points as required. Further information can be found in the proposal for this contract extension.

Table 2-1 Potential Data Sets Identified for Pre-Processing

Data Set Name	Source	Required By	Format
NMC gridded data (GDAS Forecast)	NOAA/NMC	MODIS	GRIB(1)
NMC gridded data (MRF Forecast)	NOAA/NMC	MISR, MODIS	GRIB(1)
NMC gridded data (eta analysis)	NOAA/NMC	MISR, SeaWinds, MODIS	GRIB(1)
NMC gridded data (final analysis)	NOAA/NMC	ASTER, MOPITT	GRIB(1)
TOMS Column ozone	GSFC DAAC	ASTER, MISR, MODIS	HDF, binary(2)
Snow and Ice cover	NSIDC DAAC	MISR/SeaWinds	EDR Master Map

(1) GRIB is the NMC GRidded Binary Format. This is discussed in 240-WP-002-001 and 170-TP-001-001

(2) TOMS column ozone will be available both in binary and HDF format. See later discussion.

The format of the Snow/Ice and TOMS data is discussed in the following section. The NMC GRIB native format is discussed in 170-TP-001-001.

2.1 Snow/Ice Data

The Snow/Ice coverage data is based on the DMSP SSM/I data. NESDIS receives this data and generates a 1/8th mesh, 512x512 polar stereographic grids. These grids, called EDR Master Maps, are built up from swath data. There is one file per hemisphere and one for each of the two operational DMSP satellites, giving 4 files which are updated every 6 hours. the prime longitude for the northern hemisphere maps is -80º , and for the southern hemisphere +100º. The resolution is 47.6235km at +/- 60º latitude.

Each file contains 19 master maps, containing information about a variety of derived parameters. Each master map is preceded by a two header records (each of size 1024 bytes) containing metadata for the file. These records are identical with the exception of a counter which runs from 1 to 19, incrementing for each map. The metadata contains not only general information such as spatial and temporal coverage, but also information regarding the last 29 orbits used to generate the maps. Note that if more than 29 orbits are used to construct the map, then only the last 29 orbits are detailed, any previous orbital information is lost.

All of the data values (both science and metadata) are in 2-byte "big-endian" signed integer format. For every map, a value of -1 implies a missing data point (a point not covered by any swath), a value of 254 indicates an indeterminate value for the point and a value of 255 indicates a value out of limits.

2.2 TOMS Column Ozone

The TOMS column ozone will be derived from a number of platforms (Nimbus-7, Meteor-3, EP and ADEOS). In the ECS Release A timeframe the only TOMS data set which will be available from the GSFC DAAC will be the Nimbus-7 data set.

The data set is available in a number of formats. The GSFC DAAC will have a binary and HDF format available containing daily data.

2.2.1 TOMS Binary Format

The "binary" format TOMS contains data for a single day gridded into 1º latitude by 1.25º longitude zones. Latitudes go from -90º to 0º to +90º, giving 180 latitude zones. The first latitude zone is therefore centered at -89.5º. Similarly, the longitudes go from -180º through 0º to +180º, giving 288 longitude zones.

An example of the first few lines of a data file would look like that below:

```
Day:  22 Jan 22, 1990 Production V70 NIMBUS-7/TOMS OZONE    Asc LECT: 11:16 AM
Longitudes:  288 bins centered on 179.375 W to 179.375 E  (1.25 degree steps)
Latitudes :  180 bins centered on  89.5   S to  89.5   N  (1.00 degree steps)
307307307307307307307307307307307307307307307307307307307307307308308308307
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315315315315315315315315315315315310310310310310310310310310310310310310310
310310310311311311310310310310310310310310312312312312312312312312312312312
312312309309309309309309309309309309309309309309309  0  0309309309309309309
309309309309309309309309309309309309309   lat =  -89.5
```

The first three lines are header information specifying the data format, followed by 288 data values for the first latitude zone. A zero denotes values that could not be obtained for some reason. All measurements are in Dobson Units and are integers with three significant figures.

2.2.2 TOMS HDF Format

The overall structure of a TOMS HDF File is shown in figure 2.1. These files contains a months worth of data, with daily data values stored in separate Scientific Data Sets (SDSs) in the HDF format.

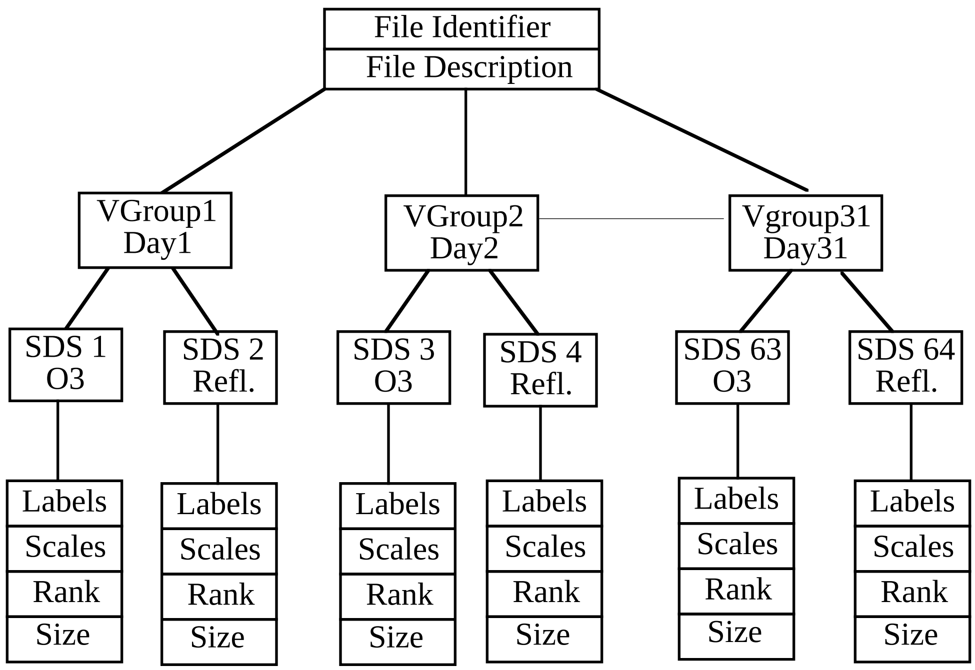

Figure 2.1 Structure of a TOMS HDF File

All of the data from a single day are grouped within an HDF VGroup structure. Within each VGroup are two SDS's of dimension 288x180, the first containing gridded ozone values and the second, gridded reflectivity values for the day.

Each SDS has associated with it a set of ASCII labels identifying the data and binary information describing the rank, size and axes scales of the data. The date associated with each grouping of two SDSs is stored as a part of the VGroup label, and is of the form "19YY: DAY-OF-YEAR DDD DATE", where YY is the year and DDD is the day of the year. The date is also included in the SDS labels.

The data is stored as 16 bit integers, with the ozone values given in Dobson units. A fill value of -777 is used for any grid point which is missing, invalid or undefined. For each SDS in the file there are 288 points in longitude in each of 180 latitude rows, the grid spacing being 1^{o} in latitude and 1.25^o in longitude. The first grid point is centered at 89.5^{o}N, 179.325^{o}W. The lat-long axes scales have been stored as 16 bit integers by multiplying by 100.

2.3 The Need for Pre-Processing

The pre-processing routines reformat data from native format to ECS standard format, namely HDF-EOS. All products generated within ECS should be in this format. This data will be archived within the ECS system for easy access. The purpose of having a standard format is so that any user can obtain any product and not have to have an understanding of the specific format in which it is written. Data can easily be extracted using standard library calls, and viewed using standard utilities.

Pre-processing of ancillary data is being performed to allow science teams to access their required data using these standard routines. If an ancillary data set is required by only a single science team, then there is no need for any pre-processing to be performed since these can be handled individually by the science teams from outside of the ECS system. For the data sets which are required by multiple science teams, there is an agreement that these be handled within ECS

The need for pre-processing of NMC GRIB and NESDIS Snow/Ice data is clear since these are not in a format which can be easily used. The case for TOMS is less clear, since HDF-EOS builds on underlying functionality of standard HDF. Since standard library routines already exist and are readily available for extracting data from the file. Given this, there is only very limited value added in pre-processing the TOMS data. Therefore, pre-processing TOMS data into HDF-EOS format is not planned at this time.

3. Object and Functional Model For Pre-Processing of NESDIS Snow/Ice Data

This section shows the proposed object model and functional model for the pre-processing of NESDIS Snow/Ice data.

3.1 Object Model

As can be seen in figure 3.1, only two classes are necessary for the required functionality; one to read and decode the native format, and one to write the data in HDF-EOS. This model fits into the Ingest Subsystem, with the class InNESDISData having the only public interface (the function "Preprocess".

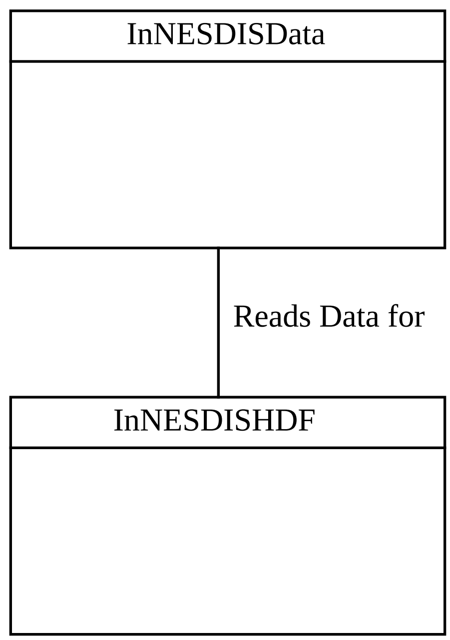

Figure 3.1 Object Model For Pre-Processing of NESDIS Snow/Ice Data

A more detailed description of these classes is given below.

3.1.1 InNESDISData

Description:

This class performs all of the unpacking of the NESDIS data from the EDR Master Map file format. It assumes that the file format conforms to that specified in the format document. Preprocessing will stop and report an error only in the case of a file which is truncated, for reasons discussed below.

Attributes:

EcTShort** myEDRScienceData

Holds an individual set of science data as a 512x512 array.

EcTFloat*` myPercentOutOfBounds

Holds the percentage of data points which are either out of bounds or indeterminate for each science data set extracted.

EcTFloat myPercentMissing

Holds the percentage of missing data, constant for all science data sets in an file.

EcTChar* myEDRFile

Name of input NESDIS data file

EcTChar* myHDFFile

Name of output file for science data

EcTChar* mySourceMCFFile

Name of MCF file from which to obtain parameters (or character string holding the same information)

EcTChar* myTargetMCFFile

Name of file to which metadata should be written

NESDISMetadata myNESDISMetadata

Structure to hold the native format metadata

Operations:

EcTInt PreProcess(EcTChar*, EcTChar*, EcTChar*, EcTChar*)

Controls the reading and extraction of data from the native format file, and calls operations in InNESDISHDF to output the required data sets in HDF-EOS.

EcTInt ReadEDRHeader()

Reads in a single EDR header record from the native format file.

EcTInt ReadEDRData()

Reads a single EDR Science data "map" from the native format file.

EcTInt ExtractMetadata()

Extracts the metadata from the header record, decodes it where necessary and fills a metadata structure.

EcTInt QCData()

Calculates the percentage of data points missing, and the percentage which are out-of-bounds or indeterminate for inclusion in the metadata.

3.1.2 InNESDISHDF

Description:

This class inserts all of the data sets extracted from the native format file into SDSs within HDF-EOS. It also writes the metadata to both an ODL file and within the HDF file. This uses the external metadata toolkit and HDF-EOS libraries.

Attributes:

NESDISInventoryMetadata myInventoryMetadata

Holds the decoded inventory metadata

NESDISArchiveMetadatamyArchiveMetadata

Holds the archive metadata structure

Operations:

EcTInt OutputToHDF (EcTInt)

Controls the output of information. Receives an integer value specifying whether to write an ODL metadata file or write the metadata to the output HDF file.

EcTInt WriteGrid()

This routine outputs a single map as a grid into the HDF-EOS format output file.

EcTInt FormatMetadata()

Arrange the metadata into two (or more) classes based on archive and inventory metadata

EcTInt WriteMetadata()

Uses the metadata toolkit libraries to write both an ODL metadata file and write the metadata to the HDF-EOS format output data file.

3.2 Functional Model

The functional model is shown below in figure 3.2. This has only been shown to one degree of leveling, since the functionality is reasonably straightforward. A description of the functions is given in the object model.

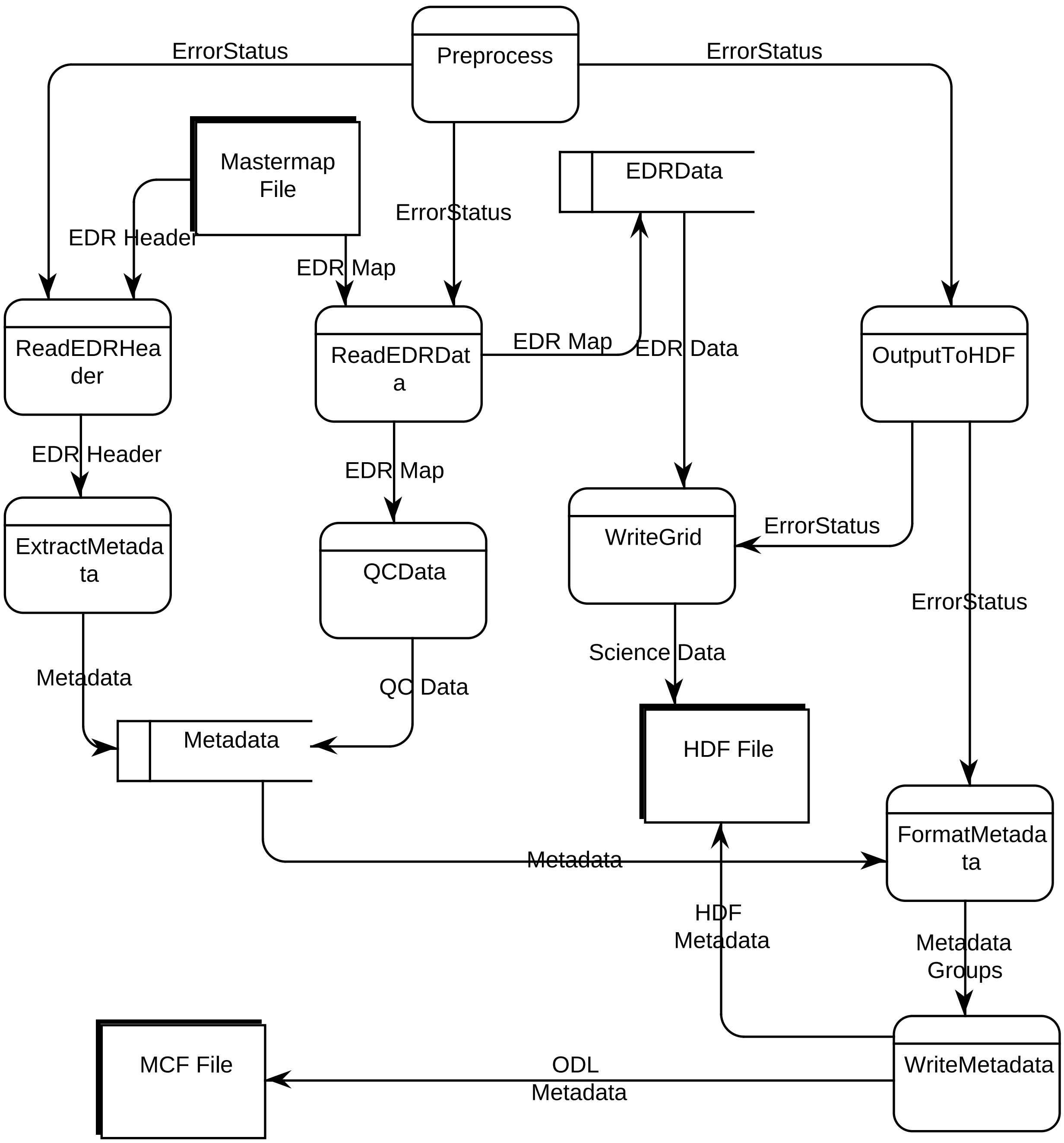

Figure 3.2 Functional Breakdown for NESDIS Snow/Ice Product Pre-Processing

3.3 Lines of Code Estimate

Table 3.1 shows the estimated lines of code required for each class. Note that this does not include library code for the PGE Toolkit or HDF-EOS, although the code will be statically linked into the final pre-processing code, but does include estimates for the class constructors and destructors.

Class	Estimated Lines of Code	External ECS Libraries
InNESDISData	500	ErrorHandling
InNESDISHDF	1000	HDF-EOS, HDF, ErrorHandling, Toolkit

Table 3.1 Lines of Code Estimate per-class

3.4 Assumptions, Issues and Risks

A number of assumptions and issues arise from the native format. It is assumed that all data will be successfully received by ECS without transcription errors, and that the data will always be as documented in "Mastermap Microwave Derived Products (EDR) Interface Control Document". This specifies the byte offsets to the start of each science map.

This latter fact gives rise to one of the main issues involved in pre-processing this data. If a file deviates from the format specified, it is unclear how this can be identified. For example, if two maps are swapped, there is no "fool-proof" way of distinguishing the fact, since maps have similar ranges and there is no difference in the metadata preceding each map. Also, since the headers and science data are all 2-byte integers with again similar ranges, it is not possible to tell if a section of data is missing and header information is being read as science data. Since it is not clear how such format errors can be detected, they will not be reported on.

The work also relies heavily on the external HDF-EOS specification and metadata toolkit libraries. Following the work already performed on the NMC GRIB pre-processing, the risks around these dependencies have been identified. The main risk in the use of the toolkit libraries is that they are being to be used outside of their designed environment (namely the PGE subsystem), and are also in a cycle of periodic upgrade based on feedback from the science community. The HDF-EOS libraries are not yet fully mature. The API's have been released for grid type data, although much of the underlying functionality may need to be altered as comments from science teams arrive. It is thought that, providing the API's remain stable, any impact from changes to HDF-EOS should be minimal.

4. Data Model For Pre-Processed NESDIS Snow/Ice Data

As stated in Section 2 of this paper, the purpose of pre-processing is to both extract metadata for use within the Ingest Subsystem and to reformat the data into HDF-EOS so that use can be made of standard libraries. HDF-EOS allows science data to be stored in a number of specific formats, namely point, grid and swath.

4.1 Choice of HDF-EOS Data Type

The native format NESDIS EDR MasterMap format file contains a total of 19 "maps" covering a range of parameters. Two of these maps are of latitude and longitude for each grid point. Thus there are two options for storing the data; as a swath or as a grid.

Since the geolocation grids are present already in the data set, it is possible to store the information as a swath. This has the advantage of being a simple approach and not relying on transformation equations to obtain the grid coordinates from the input latitude and longitude. Storing the data as an HDF-EOS grid has the advantages of (1) a smaller file size, since the geolocation grids are not required, and (2) a faster point access, since there is no need to use the geolocation arrays as look up tables.

Since this ancillary data set will be used to provide point information to science algorithms, it is thought that speed rather than simplicity, is the driving consideration. For example, if the ancillary data is needed to provide a correction to a set of swath data points, there may be several hundred calls to obtain the information from the ancillary data, and hence speed of processing outweighs the benefits associated with storing the ancillary data as a swath. Thus the data will be stored an HDF-EOS grid structure. The structural metadata is constant for each of the northern and hemisphere NESDIS products, and will not need to change, making the setting of the structural metadata straightforward.

4.2 File Format

There are a total of 19 maps present in a single MasterMap file, covering not only scientific data but also geolocation and temporal data. It is proposed to extract and reformat only a subset of the data. The data required for extraction are sea ice concentration and snow depth (NOAA-ECS Interface Control Document). Additionally, the calculated surface type will also be extracted (per communication between Graham Bland (ECS) and Pam Taylor). Thus three sets of data covering the same geolocation will be extracted for each file. This leads to the question of whether this data should be stored in a single 3-dimensional SDS, or three independent 2-D SDS's within the pre-processed file. Practically there is little difference, only slightly more HDF addressing overhead needs to be supplied if the latter option is chosen. To overcome any possible issues about the ordering of the layers with the SDS it is proposed that three single

SDS's will be written, since otherwise we would need to guarantee the order in which the data is written. This is shown diagrammatically in Figure 4.1

4.2.1 Science Data

Figure 1 shows the proposed mapping of the native format to the pre-processed product. Note that only a single header information is read and used to extract most of the metadata (with the exception of the quality information, see below). Three data maps are used from the original products, maps 11 (sea ice concentration), 16 (snow depth) and 18 (calculated surface type) will make up the science data. The values contained within these maps will not be altered. Note that a value of -1 means data is missing from this element of the grid. More information regarding the scientific data contained in the extracted sets can be found in the Mastermap Microwave Derived Products (EDR) Interface Control Document.

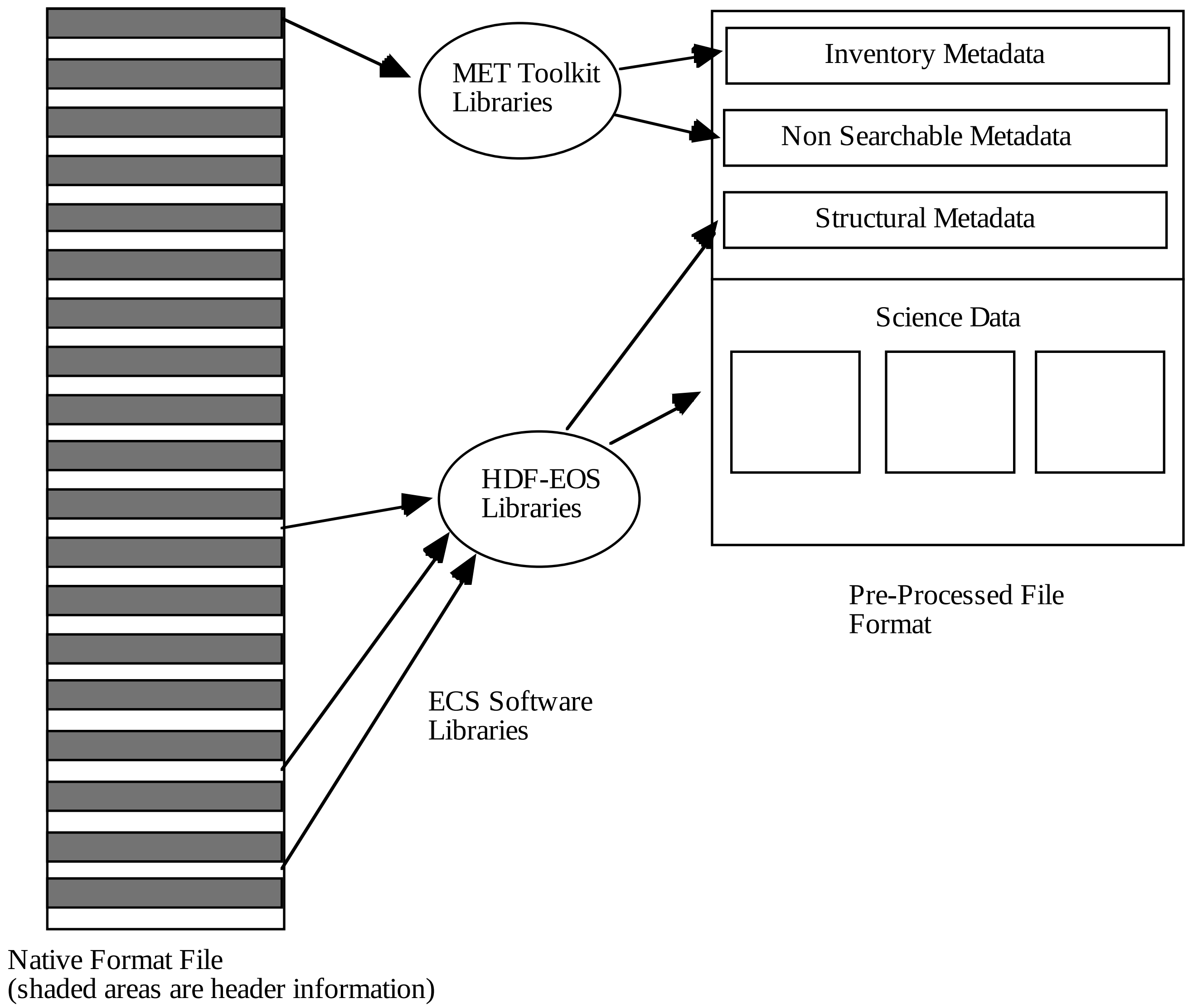

Figure 4.1 Mapping of Native Master Map Format Product to HDF-EOS

4.2.2 Metadata

An analysis of the record headers has shown that they do not vary within the file with the exception of the field for Channel Number; which seems to be a counter which is set to 1 for the first map within the file and then increment to 19 for the last map. Thus it is proposed that the header will only be extracted once for the file (not for each map). The proposed MCF is shown in Appendix A. Not all of the metadata fields will be extracted since some of the information contained is redundant, such as the start and end block numbers. Additionally, it is proposed that the metadata will be extracted and where necessary reformatted to fit with the metadata required within ECS. That is the pre-processed file will contain decoded information. For example, the projection type is always set to 2 within the header of the native format file , but this would be written as "polar stereographic" in the pre-processed file.

Some information can not be obtained directly from the header record, specifically the quality information regarding the percentage of missing data and percentage of data out of bounds. These will be obtained directly from the data by counting the number of data points flagged either with a value of -1 (missing data) or 254/255 (data indeterminate/out of range). Note that the percentage of data out of range will be the percentage of data points present that are out of range, not the percentage of the total possible data points (including missing data).

A further complication arises regarding the start and stop orbit numbers from which data is used to build up the master map. Only the orbit numbers of the last 29 orbits are recorded in the file metadata, although it is possible that maps are actually constructed from more than this number of orbits. It is proposed that the orbit numbers given in the pre-processed file are only those listed in the last 29, since it is unclear whether orbit "gaps" could occur.

In lines with current ECS guidelines, the metadata is written in two groups; inventory metadata metadata (that required to perform search queries on the data) and archive metadata (data which is useful in analyzing the product, but is not searchable). The only further complication is that NESDIS Snow/Ice data forms a single collection, which should have a single platform associated with it. However, the data actually comes from two sources, the DMSP satellites F-10 and F-11. This is overcome in the metadata file using the "parameter name" and "parameter value" construction.

Abbreviations and Acronyms

API	Application Program Interface
ASTER	Advanced Space Borne Thermal Emission and Reflection Radiometer
ADEOS	Advanced Earth Observing System
CCR	Contract Change Request
DAAC	Distributed Active Archive Center
DMSP	Defense Meteorological Sensing Platform
ECS	EOSDIS Core System
EDR	Environmental Data Record
EP	Earth Probe
GRIB	Gridded Binary
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
MCF	Metadata Configuration File
MISR	Multiangle Imaging Spectroradiometer
MODIS	Moderate Resolution Imaging Spectroradiometer
MOPITT	Measurement of Pollution in the Troposphere
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data and Information Service
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
PDPS	Planning and Data Processing Subsystem
PGE	Product Generation Executive
SSM/I	Special Sensor Microwave/Imager
TOMS	Total Ozone Mapping Spectrometer

Appendix A Metadata Configuration File

```
GROUP = INVENTORYMETADATA
GROUPTYPE = MASTERGROUP
	OBJECT = ShortName
		Data_Location = "MCF"
		Value = "NESDIS Snow/Ice"
		Mandatory = “TRUE”
		NUM_VAL = 1
		TYPE = “STRING”
	END_OBJECT = ShortName

	OBJECT = SizeMBECSDataGranule
		Data_Location = "MCF"
		Value = 3
		Mandatory = “TRUE”
		NUM_VAL = 1
		TYPE = “INTEGER”
	END_OBJECT = SizeMBECSDataGranule

	OBJECT = EastBoundingCoordinate
		Data_Location = "MCF"
		Value = 180.00
		Mandatory = “TRUE”
		NUM_VAL = 1
		TYPE = “DOUBLE”
	END_OBJECT = EastBoundingCoordinate
```

```
OBJECT = WestBoundingCoordinate
	Data_Location = "MCF"
	Value = -180.00
	Mandatory = “TRUE”
	NUM_VAL = 1
	TYPE = “DOUBLE”
END_OBJECT = WestBoundingCoordinate

OBJECT = NorthBoundingCoordinate
	Data_Location = "PGE"
	Mandatory = “TRUE”
	NUM_VAL = 1
	TYPE = “DOUBLE”
END_OBJECT = NorthBoundingCoordinate

OBJECT = SouthBoundingCoordinate
	Data_Location = "PGE"
	Mandatory = “TRUE”
	NUM_VAL = 1
	TYPE = “DOUBLE”
END_OBJECT = SouthBoundingCoordinate

OBJECT = RangeBeginningDate
	Data_Location = "PGE"
	Mandatory = "TRUE"
	NUM_VAL = 1
	TYPE = “STRING”
END_OBJECT = RangeBeginningDate
```

```
OBJECT = RangeBeginningTime
        Data_Location = "PGE"
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “STRING”
END_OBJECT = RangeBeginningTime

OBJECT = RangeEndingDate
        Data_Location = "PGE"
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “STRING”
END_OBJECT = RangeEndingDate

OBJECT = RangeEndingTime
        Data_Location = "PGE"
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “STRING”
END_OBJECT = RangeEndingTime

OBJECT = QAPercentMissingData
        Data_Location = "PGE"
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “DOUBLE”
END_OBJECT = QAPercentMissingData

OBJECT = ParameterName
```

```
        Data_Location = "MCF"
        Value = "Platform"
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “STRING”
    END_OBJECT = ParameterName

    OBJECT = ParameterValue
        Data_Location = "PGE"
        Mandatory = "TRUE"  /* Set to either F-10 or F-11 */
        NUM_VAL = 1
        TYPE = “STRING”
    END_OBJECT = ParameterValue
END_GROUP = INVENTORYMETADATA

GROUP = ARCHIVEMETADATA
GROUPTYPE = MASTERGROUP
    OBJECT = Sensor
        Data_location = "MCF"
        Value = "SSM/I"
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “STRING”
    END_OBJECT = Sensor

    OBJECT = LatitudeResolution
        Data_Location = "MCF"
        Value = 47.625
        Mandatory = "TRUE"
```

NUM_VAL = 1

TYPE = “DOUBLE”

END_OBJECT = LatitudeResolution

OBJECT = LongitudeResolution

Data_Location = "MCF"

Value = 47.625

Mandatory = "TRUE"

NUM_VAL = 1

TYPE = “DOUBLE”

END_OBJECT = LongitudeResolution

OBJECT = GeographicCoordinateUnits

Data_Location = "MCF"

Value = "km"

Mandatory = "TRUE"

NUM_VAL = 1

TYPE = “STRING”

END_OBJECT = GeographicCoordinateUnits

OBJECT = StartOrbitNumber

Data_Location = "PGE"

Mandatory = "TRUE"

NUM_VAL = 1

TYPE = “INTEGER”

END_OBJECT = StartOrbitNumber

OBJECT = StopOrbitNumber

Data_Location = "PGE"

```
        Mandatory = "TRUE"
        NUM_VAL = 1
        TYPE = “INTEGER”
    END_OBJECT = StopOrbitNumber

/****************************************************/
/* For the percentage of data out of bounds, there are          */
/* three distinct values, one for each SDS.  In the             */
/* description below, these are represented by three            */
/* instances of the object.  In implementation, the             */
/* following mapping between classes and SDS's will             */
/* be maintained:                                               */
/*      Class 1 : Sea Ice Concentration                         */
/*      Class 2 : Snow Depth                                    */
/*      Class 3 : Calculated surface type                       */
/* Note that this percentage is the percentage of data          */
/* available which is marked as either out-of-limits or         */
/* indeterminate, not the percentage of all possible            */
/* data points.                                                 */
/****************************************************/

GROUP = QAContainerGroup
    OBJECT = QAContainerObject
        Data_Location = "NONE"
        Class = "M"
        Mandatory = "TRUE"

        OBJECT = QAPercentOutOfBounds
            Data_Location = "PGE"
```

```
                Class = "M"
                Mandatory = "TRUE"
            END_OBJECT = QAPercentOutOfBounds
        END_OBJECT = QAContainerObject
END_GROUP = QAContainerGroup
END_GROUP = ARCHIVEMETADATA
END
```